UNIT V

EMERGING ISSUES

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

ALTERNATE CULTURE SYSTEMS

ALTERNATIVE CROP PLANTS

By alternative crop plants, referring to agriculturally useful plants,

The description and discussion of the alternative crop plants is subdivided into starch plants (old wheat species, millet, buckwheat, amaranth, quinoa), sugar plants (chicory, Jerusalem artichoke), oil plants (Abessinian cale, gold of pleasure, safflower), fibre plants (fibre nettle), medicinal and spice plants, dye plants as well as useful plants for energetic use (sweet sorghum, Sudan grass, miscanthus, poplar, willow).

What all of the alternative crop plants discussed have in common is that they are not cultivated, or if so only on a very small scale. Accordingly these crop plants still display typical wild plant characteristics, including:

A low level of output;

Poor stability of yield, i.e. substantial fluctuations in yield occur from year to year depending on the weather;

Irregular maturation, which makes it difficult to determine an optimal harvest time (e.g. proso millet, buckwheat);

High failure and crop losses, whereby the potential yield is only partially exploited (e.g. buckwheat, amaranth);

Weed infestation of subsequent crops caused by fallen seeds or root remnants (e.g. quinoa, Jerusalem artichoke).

The cultivation of medicinal and spice plants represents a particularly valuable contribution to the increase of agricultural biodiversity due to the small area required for cultivation of the respective species. The multiplier effect in the agrarian ecosystem is particularly apparent here: Biodiversity is not only enriched by the cultivation of different plant species, but rather as blossoming plants these provide attractive sites for numerous insects. However the positive effect of such niche production is slight when related to the total area.

The use of pesticides and fertilizers would in general be reduced through alternative crop plants. With regard to the control of diseases and pests in particular, alternative crop plants bring about an expansion of the rotation of crops, which could also reduce the use of pesticides on market fruit. The undemanding nature of the alternative crop plants, their low level of output and their excellence for low-yield sites require an extensive management. In the areas where competitiveness over established crop plants can only be achieved through higher yields, such yield increases would certainly also lead to more intensive farming.

A growing interest in alternative crop plants also persists for use as a renewable primary product. A low level of output, a lack of varieties acclimatized to the habitat, little cultivation and different cultivation risks however lead to the situation. Opportunities arise with alternative starch plants, for proso millet and pseudo cereals in particular, as surrogates for cereal products for people suffering from celiac disease and neurodermatitis. The cultivation of the millet crop species cane an interesting alternative for organic farms on light soils and sites tending towards dryness. Increasing demand has to date been almost exclusively met by imports. A greater interest in cultivation would boost research and breeding. Cultivation endeavors indicate potentials for suitable, stable yield varieties for farming.

Organic farming is an alternative agricultural system which originated early in the 20th century in reaction to rapidly changing farming practices. It is defined by the use of fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. Biological pest control, mixed cropping and the fostering of insect predators are encouraged.

Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organic farming organizations established in 1972. Organic agriculture can be defined as:

An integrated farming system that strives for sustainability, the enhancement of soil fertility and biological diversity whilst, with rare exceptions, prohibiting synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms, and growth hormones.

MEGA FARMS AND VERTICAL FARMS

Megafarms have been responsible for pollution to rivers and waterways. Animals are often fed with imported corn and soya, the majority of which is genetically modified to withstand high doses of the controversial herbicide glyphosate. Industrial-scale horticulture operations tend to rely on imported minerals for plant feed, use significant amounts of energy for heating and produce a low diversity of crops.

Research shows that conservation areas cannot make up for the environmental damage of intensive farms. Even if megafarms were interspersed within vast landscapes of parks and woodlands, it still wouldn’t help.

Without addressing this, it is likely that, as farmers leave, land will be bought by investors and by large farm businesses, continuing the current trend of consolidation and rising farmland prices. Young farmers and other new entrants might be desperately needed to reverse the UK's declining farming population, but they will continue to struggle to get hold of land.

Hard to eat by selling food

One of the main reasons why megafarms have become popular and smaller farms have gone under is because farms only receive a small fraction of the retail value of food. Combined with low agricultural commodity prices, it is nearly impossible for farmers to earn a living from the food they produce.

The Agriculture Bill does propose some new powers to collect data about the supply chain, a move which should mean more transparency but which is unlikely to result in farmers receiving significantly more money. If landowners are paid for protecting the environment, but receive little for food production, there is a good chance that farm land will be used for conservation, not farming.

Low-tech practices such as growing different crops in the same space (poly-cropping) or agroforestry can increase yields of diverse foods and regenerate soil, all while minimizing harmful inputs. This could help support existing farms which have struggled with long-term soil deterioration and feel "locked-in" to using certain agro-chemicals. But these approaches are knowledge-intensive and take time to implement. Without support for them it is likely that farmers will continue to either leave the business or intensify.

The shift towards megafarms is not inevitable or necessary. Defra has included some measures to support ecological and human-scale farming, such as a nod towards reducing pesticide use, and a support for County Farms which can help new entrants. However, much more is needed to ensure that farming and the environment are truly integrated.

VERTICAL FARMS

A building in which crops are grown commercially in multiple layers or levels.

Vertical farming is the practice of producing food and medicine in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures (such as in a skyscraper, used warehouse, or shipping container). The modern ideas of vertical farming use indoor farming techniques and controlled-environment agriculture (CEA) technology, where many environmental factors can be controlled. These facilities utilize artificial control of light, environmental control (humidity, temperature, gases...) and fertigation. Some vertical farms use techniques similar to greenhouses, where natural sunlight can be augmented with artificial lighting and metal reflectors.

Hydroponic systems can be lit by LEDs that mimic sunlight. Software can ensure that all the plants get the same amount of light, water and nutrients. Proper management means that no herbicides or pesticides are required.

Each floor will have its own watering and nutrient monitoring systems. There will be sensors for every single plant that tracks how much and what kinds of nutrients the plant has absorbed. You'll even have systems to monitor plant diseases by employing DNA chip technologies that detect the presence of plant pathogens by simply sampling the air and using snippets from various viral and bacterial infections. It's very easy to do.

Moreover, a gas chromatograph will tell us when to pick the plant by analyzing which flavonoids the produce contains. These flavonoids are what gives the food the flavors you're so fond of, particularly for more aromatic produce like tomatoes and peppers. These are all right-off-the-shelf technologies. The ability to construct a vertical farm exists now. We don't have to make anything new.

Types

The term "vertical farming" was coined by Gilbert Ellis Bailey in 1915 in his book Vertical Farming. His use of the term differs from the current meaning he wrote about farming with a special interest in soil origin, its nutrient content and the view of plant life as "vertical" life forms, specifically relating to their underground root structures. Modern usage of the term "vertical farming" usually refers to growing plants in layers, whether in a multistory skyscraper, used warehouse, or shipping container.

Mixed-use skyscrapers

Mixed-use skyscrapers were proposed and built by architect Ken Yeang. Yeang proposes that instead of hermetically sealed mass-produced agriculture, plant life should be cultivated within open air, mixed-use skyscrapers for climate control and consumption. This version of vertical farming is based upon personal or community use rather than the wholesale production and distribution that aspires to feed an entire city.[6]

Despommier's skyscrapers

Ecologist Dickson Despommier argues that vertical farming is legitimate for environmental reasons. He claims that the cultivation of plant life within skyscrapers will require less embodied energy and produce less pollution than some methods of producing plant life on natural landscapes. By shifting to vertical farms, Despommier believes that farmland will return to its natural state (i.e. forests), which would help reverse the impacts of climate change. He moreover claims that natural landscapes are too toxic for natural agricultural production. Vertical farming would remove some of the parasitic risks associated with farming. [7]

Despommier's concept of the vertical farm emerged in 1999 at Columbia University. It promotes the mass cultivation of plant life for commercial purposes in skyscrapers.[8]

Stackable shipping containers

Several companies have developed stacking recycled shipping containers in urban settings. Brighter side Consulting created a complete off-grid container system. Farms produces a "leafy green machine" that is a complete farm-to-table system outfitted with vertical hydroponics, LED lighting and intuitive climate controls built within a 12 m × 2.4 m shipping container. Podponics built a vertical farm in Atlanta consisting of over 100 stacked "grow pods". A similar farm is under construction in Oman. Terra Farms offer a proprietary system of 40 foot shipping containers, which include computer vision integrated with an artificial neural network to monitor the plants; and are remotely monitored from California. It is claimed that the TerraFarm system "has achieved cost parity with traditional, outdoor farming" with each unit producing the equivalent of "three to five acres of farmland", using 97% less water through water recapture and harvesting the evaporated water through the air conditioning. As of December 2017 the TerraFarm system was in commercial operation. Plants can exploit light that varies in intensity through the day. Controlling light governs the growth cycle of the plant. E.g., infrared LEDs can mimic 5 minutes of sunset, stimulating some plants to begin flowering.

In abandoned mine shafts

Vertical farming in abandoned mine shafts is termed "deep farming," and is proposed to take advantage of consistent underground temperatures and locations near or in urban areas.[17]

Problems

Economics

Opponents question the potential profitability of vertical farming. Its economic and environmental benefits rest partly on the concept of minimizing food miles, the distance that food travels from farm to consume. However, a recent analysis suggests that transportation is only a minor contributor to the economic and environmental costs of supplying food to urban populations. The analysis concluded that "food miles are, at best, a marketing fad". Thus the facility would have to lower costs or charge higher prices to justify remaining in a city.

Similarly, if power needs are met by fossil fuels, the environmental effect may be a net loss; even building low-carbon capacity to power the farms may not make as much sense as simply leaving traditional farms in place, while burning less coal.

The developers of the TerraFarm system produced from second hand, 40 foot shipping containers claimed that their system "has achieved cost parity with traditional, outdoor farming".[

Energy use

During the growing season, the sun shines on a vertical surface at an extreme angle such that much less light is available to crops than when they are planted on flat land. Therefore, supplemental light would be required. Bruce Bugbee claimed that the power demands of vertical farming would be uncompetitive with traditional farms using only natural light. Even though crops growing in a glass skyscraper will get some natural sunlight during the day, it won't be enough" and "the cost of powering artificial lights will make indoor farming prohibitively expensive".

As "The Vertical Farm" proposes a controlled environment, heating and cooling costs will resemble those of any other tower. Plumbing and elevator systems are necessary to distribute nutrients and water.

Pollution

Depending on the method of electricity generation used, greenhouse produce can create more greenhouse gases than field produce, largely due to higher energy use per kilogram. Vertical farms require much greater energy per kilogram versus regular greenhouses, mainly through increased lighting. The amount of pollution produced is dependent on how the energy is generated.

Greenhouses commonly supplement CO_2 levels to 3–4 times the atmospheric rate. This increase in CO_2 increases photosynthesis rates by 50%, contributing to higher yields. Some greenhouses burn fossil fuels purely for this purpose, as other CO_2 sources, such as those from furnaces, contain pollutants such as sulphur dioxide and ethylene which significantly damage plants.This means a vertical farm requires a CO_2 source, most likely from combustion.

Advantages

Many of VF's potential benefits are obtained from scaling up hydroponic or aeroponic growing methods.

The study's quantitative framework projected

Annual food production of 100–180 million tonnes

Energy savings ranging from 14 to 15 billion kilowatt hours,

Nitrogen sequestration between 100,000 and 170,000 tonnes and

Storm water runoff reductions between 45 and 57 billion cubic meters annually.

Food production, nitrogen fixation, energy savings, pollination, climate regulation, soil formation and biological pest control could be worth as much as $80–160 billion annually.

Preparation for the future

It is estimated that by the year 2050, the world's population will increase by 3 billion people and close to 80% will live in urban areas. Vertical farms have the potential to reduce or eliminate the need to create additional farmland.

Increased crop production

Unlike traditional farming in non-tropical areas, indoor farming can produce crops year-round. All-season farming multiplies the productivity of the farmed surface by a factor of 4 to 6 depending on the crop. With crops such as strawberries, the factor may be as high as 30.

Furthermore, as the crops would be consumed where they are grown, long-distance transport with its accompanying time delays, should reduce spoilage, infestation and energy needs. Globally some 30% of harvested crops are wasted due to spoilage and infestation, though this number is much lower in developed nations.

Weather disruption

VF productivity is mostly independent of weather, although earthquakes and tornadoes still pose threats.

Conservation

Vertical farming would thus reduce the amount of farmland, thus saving many natural resources. Deforestation and desertification caused by agricultural encroachment on natural biomes could be avoided. Producing food indoors reduces or eliminates conventional plowing, planting, and harvesting by farm machinery, protecting soil and reducing emissions.

Resource scarcity

The scarcity of fertilizer components like phosphorus poses a threat to industrial agriculture. The closed-cycle design of vertical farm systems minimizes the loss of nutrients.

Mass extinction

In comparison, vertical farming would cause nominal harm to wildlife.

Human health

Traditional farming is a hazardous occupation that often affects the health of farmers. Such risks include: exposure to infectious agents such as malaria and schistosomes, as well as soil-borne microbes, exposure to toxic pesticides and fungicides, confrontations with wildlife such as venomous snakes, and injuries that can occur when using large industrial farming equipment. VF reduces some of these risks.

Poverty and culture

Food insecurity is one of the primary factors leading to absolute poverty. Constructing farms will allow continued growth of culturally significant food items without sacrificing sustainability or basic needs, which can be significant to the recovery of a society from poverty.

Urban growth

Vertical farming, used in conjunction with other technologies and socioeconomic practices, could allow cities to expand while remaining substantially self-sufficient in food. This would allow large urban centers to grow without food constraints.

Energy sustainability

Vertical farms could exploit methane digesters to generate energy. Methane digesters could be built on site to transform the organic waste generated at the farm into biogas that is generally composed of 65% methane along with other gases. This biogas could then be burned to generate electricity for the greenhouse.

Technologies and devices

Vertical farming relies on the use of various physical methods to become effective. Combining these technologies and devices in an integrated whole is necessary to make Vertical Farming a reality. Various methods are proposed and under research. The most common technologies suggested are:

Greenhouses

The Folkewall and other vertical growing architectures

Aeroponics

Agricultural robot

Aquaponics

Composting

Controlled-environment agriculture

Flower pots

Grow lights

Hydroponics

Phytoremediation

Precision agriculture

Skyscrapers

TerraFarm